IS 11656 (1986): Antiwear Hydraulic Oil, Extra Heavy Duty Type [PCD 3: Petroleum, Lubricants and their Related Products]

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Indian Standard

SPECIFICATION FOR ANTIWEAR HYDRAULIC OIL, EXTRA HEAVY DUTY TYPE

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

SPECIFICATION FOR ANTIWEAR HYDRAULIC OIL, EXTRA HEAVY DUTY TYPE

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Indian Standard

SPECIFICATION FOR ANTIWEAR HYDRAULIC OIL, EXTRA HEAVY DUTY TYPE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 3 March 1986, after the draft finalized by the Lubricants and Related Products Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council.

0.2 Antiwear hydraulic oils are generally used for the lubrication of axial, piston, vane and gear pumps. These heavy duty type of antiwear hydraulic oils are especially required for use in oil operated fluid power systems that are subjected to shock loads, variable speed for continuous operating conditions of high severity. These oils are also used for moderately loaded industrial gears, bearings and hydraulic devices with hydro-mechanical actuator.

0.3 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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1. SCOPE

1.1 This standard prescribes the requirements and methods of sampling and tests for antiwear hydraulic oils, extra heavy duty type.

2. GRADES

2.1 The material shall be available in five viscosity grades, namely, VG 32, VG 46, VG 68, VG 100 and VG 150.

*Rules for rounding off numerical values (*revised*).

3. REQUIREMENTS

3.1 General — The material shall be made from refined mineral base stocks of high viscosity index and shall contain suitable additives to give satisfactory performance. It shall be clear and free from water, dirt and suspended impurities.

3.2 The material shall also comply with the requirements given in Table 1 when tested according to the methods prescribed in 'P' series of IS : 1448* and Appendices. Reference to the relevant test methods is given in col 8 and 9 of Table 1.

4. PACKING AND MARKING

4.1 Packing — The material shall be packed in containers of metal or any other suitable material as agreed to between the purchaser and the supplier.

4.2 Marking — The containers shall be securely closed and marked with the name of the manufacturer; grade and mass of the material; recognized trade-mark, if any; and identification in code or otherwise to enable the lot of consignment or manufacture to be traced back.

4.2.1 The containers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

5. SAMPLING

5.1 Representative samples of the material shall be drawn as prescribed in IS : 1447-1966†.

5.2 Number of Tests — Tests for determining all the characteristics given in Table 1 shall be conducted on the composite sample.

5.3 Criteria for Conformity — The test shall be declared as conforming to the requirements of the specification if all the test results on the composite sample meet the relevant specification requirements.

*Methods of test for petroleum and its products.

†Methods of sampling of petroleum and its products.

TABLE 1 REQUIREMENTS FOR ANTIWEAR HYDRAULIC OILS, EXTRA HEAVY DUTY TYPE

(*Clauses* 3.2 *and* 5.2)

Sl No.	Characteristic	Requirement					Method of Test, Ref to	
		Grade VG 32	Grade VG 46	Grade VG 68	Grade VG 100	Grade VG 150	Appendix	(P:) of IS : 1448*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Kinematic viscosity at 40° C, cSt	28·8 to 35·2	41·4 to 50·6	61·2 to 74·8	90 to 110	135 to 165	—	P : 25
ii)	Viscosity index, *Min*	90	90	90	90	90	—	P : 56
iii)	Pour point, °C, *Max*	−3	−3	0	0	0	—	P : 10
iv)	Flash point (COC), °C, *Min*	180	180	210	210	230	—	P : 69
v)	Neutralization number, mg KOH/g of oil, *Max*	←——To be reported——→					—	P : 1
vi)	Rust preventing characteristics	←——Shall pass the test B after 24 h——→					—	P : 96
vii)	Copper strip corrosion for 3 hours at 100°C	←——Not worse than 1——→					—	P : 15
viii)	Foaming test							P : 67
	Foam stability after 10 minutes setting time, foam; ml							
	a) At 24°C, *Max*	←——Nil——→						
	b) At 93°C, *Max*	←——Nil——→						
	c) At 24°C after cooling down from 93°C, *Max*	←——Nil——→						

*Methods of test for petroleum and its products.

(*Continued*)

TABLE 1 REQUIREMENTS FOR ANTIWEAR HYDRAULIC OILS, EXTRA HEAVY DUTY TYPE — *Contd*

Sl No.	Characteristic	Requirement					Method of Test, Ref to	
		Grade VG 32	Grade VG 46	Grade VG 68	Grade VG 100	Grade VG 150	Appendix	(P :) of IS : 1448*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ix)	Emulsion characteristics, *Max*	←——40-37-3 (20)——→		←——40-37-3 (30)——→			—	P : 91
x)	†Air release value, minutes to 0·2 percent volume air content at 50°C, *Max*	7	10	15	20	25	—	P : 102
xi)	†Oxidation test for 1 000 hours:						—	P : 106
	a) Neutralization number of oil, mg KOH/g, *Max*	←——————2·0——————→						
	b) Total sludge in oil and water layer plus those adhering to the catalyst coils or test tube mg, *Max*	←——————100——————→						
	c) Metal in combined oil, water and sludge							
	i) Copper, mg, *Max*	←——————50——————→						
	ii) Iron, mg, *Max*	←——————50——————→						
xii)	†Hydrolytic stability :						—	P : ‡
	a) Copper specimen mass loss, mg/cm², *Max*	←——————0·5——————→						
	b) Acidity of water layer, mg, KOH, *Max*	←——————6·0——————→						

xiii) †Four ball wear test at 20 kg load; Wear scar diameter, mm, *Max*	←——0·35——→	—	P : §
xiv) †Pump wear test (Vickers 104C, 250 hours test); Total mass loss to rings and vanes; mg, *Max*	←——50——→	—	P : ‖
xv) †FZG-Niemann EP test, pass load stage, *Min*	←——10 th——→	—	P : ¶
xvi) †Thermal stability test at 135°C for 168 hours:		A	—
a) Viscosity increase, percent, *Max*	←——5——→		
b) Sludge mg/100 ml, *Max*	←——25——→		
c) Copper rod mass, loss, mg/200 ml, *Max*	←——10——→		
d) Copper rod rating, *Max*	←——2——→	—	P : 15
xvii) †Filterability test; Filtration time seconds:		B	—
a) Without water, *Max*	←——600——→		
b) With 2 percent water, *Max*	←——Twice the time without water——→		
xviii) †Seal compatibility test:		C	—
a) Volume change, percent, *Max*	←——±4——→		
b) Change in shore hardness, *Max*	←—— − 1 to +4——→		

*Methods of test for petroleum and its products.
†These are type tests for which manufacturers/suppliers shall give the guarantee for their compliance.
‡Under preparation — Till such time ASTM D 2619-75 shall be followed.
§Under preparation — Till such time ASTM D 2266-67 shall be followed.
‖Under preparation — Till such time IP-281-77 shall be followed.
¶Under preparation — Till such time CEC —L —07 —A —71 or DIN 51354 shall be followed.

APPENDIX A

[*Table* 1, *Sl No.* (xvi)]

THERMAL STABILITY TEST

A-1. CLEANING AND HANDLING OF CATALYST RODS BEFORE HEAT TEST

A-1.1 The rods used as the catalyst in this test are copper (99·9 percent electrolytic copper) and steel (1 percent carbon) rods, 6·5 mm diameter × 75 mm length.

A-1.2 New rods and previously used rods shall be cleaned adequately to prevent contamination of the sample tested. Cleaning of rods is accomplished using 320 grit abrasive cloth to remove all surface contamination and to bring the surface to a bright copper and/or steel appearance. Rods should be placed in a drill chuck or other suitable means of rotation.

A-1.3 Polishing of these rods is accomplished using crocus cloth. Handling of the rods in the polishing operation should be with cotton gloves or with facial tissue.

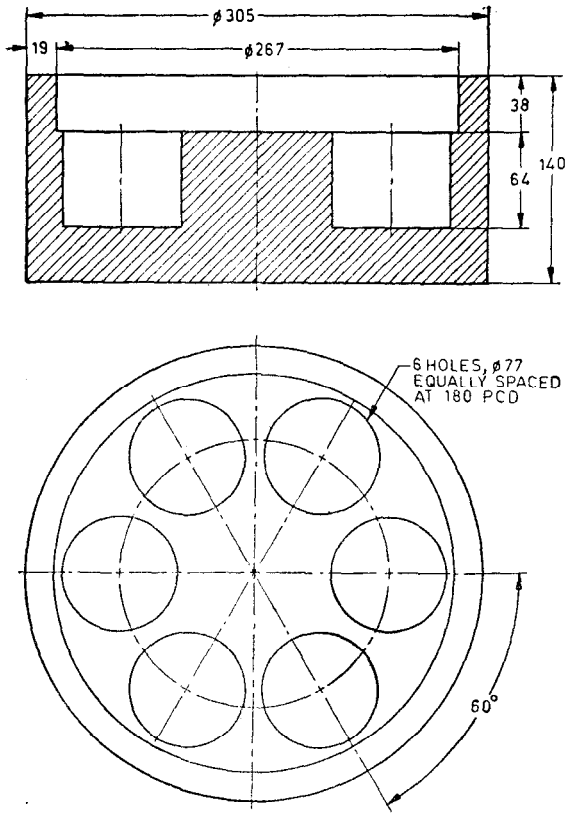
A-1.4 Upon completion of the polishing operation, the rods are washed individually with acetone, dried and weighed (to the nearest 0·1 mg) and placed into the oil sample. All handling of rods is with clean white gloves, tissue or forceps.

A-2. HEAT TEST PROCEDURE

A-2.1 Place clean polished preweighed copper and steel rods in a 250 ml Griffin beaker which contains 200 ml of the oil sample. Be sure that the rods are totally below the surface of the oil and in contact with each other before beginning heat test. The beaker and contents are placed in an aluminium test fixture (*see* Fig. 1) in an electric gravity convection oven for 168 hours. The oven temperature is to be maintained at 135 ± 1°C. The aluminium fixture lends itself to uniform temperature distribution and control of all oil samples. Upon completion of the 168 hours in the oven, the sample(s) is/are removed and allowed to cool to room temperature before proceeding.

A-3. EVALUATION OF COPPER AND STEEL RODS

A-3.1 The rods are individually removed from the oil sample. Any loose sludge is removed from the rod and returned into the oil using a plastic policeman tip.



All dimensions in millimetres.

FIG. 1 ALUMINIUM TEST FIXTURE

A-4. COPPER ROD ANALYSIS

A-4.1 After having removed the loose sludge with a plastic policeman tip, the rod is washed with acetone to remove all oil and then air dried. The rod is weighed (to the nearest 0·1 mg) and the mass recorded. Visual evaluation of the condition of the copper rod should be made and recorded.

A-4.2 Place copper rod in a 10 percent solution of KCN (CAUTION — Handle Potassium Cyanide with care) at room temperature for one minute with agitation. Remove rod from solution and wash immediately in distilled water, follow with an acetone wash and air dry. Weigh the rod to the nearest 0·1 mg and record the mass.

A-5. STEEL ROD ANALYSIS

A-5.1 After having removed the loose sludge with a plastic policeman tip, the rod is washed with naphtha and dried in air. The rod is weighed (to the nearest 0·1 mg) and the mass recorded. Visual evaluation of the rod for appearance and discolouration is made and evaluation recorded.

A-5.2 After weighing, the rod is placed in a 20 percent sodium hydroxide solution at 82°C for 15 minutes. Upon removal from the sodium hydroxide solution, the rod is wiped immediately with tissue to remove the softened lacquer. Wash rod with distilled water, followed by an acetone wash. Wipe dry with tissue. Weigh the rod to the nearest 0·1 mg and record the mass.

A-6. EVALUATION OF THE OIL

A-6.1 Precipitate and/or Sludge Determination — The total amount of oil is filtered through a preweighed (to the nearest 0·1 mg) No. 41 Whatman filter paper. No solvent is used to rinse beaker at this time. The oil filtrate is removed from the flask and retained for further evaluation (*see* **A-6.1.1** and **A-6.2**). Wash all remaining residue from the beaker with naphtha, to the No. 41 Whatman filter paper. Wash the residue on the filter paper with naphtha until all evidence of oil is removed from the residue. Air dry the residue and filter paper. Weigh residue and paper to the nearest 0·1 mg. Determine the mass of residue from 200 ml of oil by subtracting mass of filter pad and record the information.

A-6.1.1 From the oil filtrate, pipette 25 ml of oil and filter through a preweighed (to the nearest 0·1 mg) 8 micron millipore filter pad. Wash residue, air dry and weigh (to the nearest 0·1 mg). Record the mass of residue.

A-6.2 Viscosity Change — From the remaining filtrate (*from* **A-6.1**) determine the viscosity by IS : 1448 [P : 25]-1976* and calculate percent change in viscosity from the original sample.

A-6.3 Neutralization Number — From the oil filtrate (**A-6.1**) determine the neutralization number by IS : 1448 [P : 1]-1971†.

A-6.4 Sample Calculations

A-6.4.1 *Copper Rod Sample Calculations*

a) Sludge deposit

1) Mass in g of rod after heat test	$= M_1$
2) Mass in g of rod after KCN strip	$= M_2$
Mass in g deposited on rod	$= (M_1 - M_2)$
Mass in mg deposited on rod	$= 1\,000\,(M_1 - M_2)$

*Methods of test for petroleum and its products: [P : 25] Determination of kinematic and dynamic viscosity (*first revision*).

†Methods of test for petroleum and its products: [P : 1] Neutralization number by potentiometric titration (*first revision*).

b) Metal loss

1) Mass in g of original rod $= M_3$

2) Mass in g of rod after KCN strip $= M_2$

Metal loss in g $= (M_3 - M_2)$

Metal loss in mg $= 1\,000\,(M_3 - M_2)$

A-6.4.2 *Steel Rod Sample Calculations*

a) Lacquer deposit

1) Mass in g of rod after heat test $= M_4$

2) Mass in g of rod after NaOH strip $= M_5$

Mass in g of rod lacquer deposit $= (M_4 - M_5)$

Mass in mg of lacquer deposit $= 1\,000\,(M_4 - M_5)$

b) Metal loss

1) Mass in g of original rod $= M_6$

2) Mass in g of rod after NaOH strip $= M_5$

Metal loss in g $= (M_6 - M_5)$

Metal loss in mg $= 1\,000\,(M_6 - M_5)$

A-6.4.3 *Total Sludge Sample Calculation*

a) Mass in g of sludge on No. 41 Whatman paper $= M_7$

(divide residue mass by 2 to give mass/100 ml) $= M_7/2$ per 100 ml

b) Mass in g of sludge on 8 micron pad $= M_8$

(residue mass of 25 ml × 4 to give mass/100 ml) $= 4 \times M_8$ per 100 ml

c) Mass in g of sludge removed from copper rod

(residue mass divided by 2 to give mass/100 ml)

$$= \frac{(M_1 - M_2)}{2} \text{ per 100 ml}$$

$$\text{Total sludge in g} = \frac{M_7}{2} + 4M_8 + \frac{M_1 - M_2}{2}$$

$$= 1\,000 \left[\frac{M_7}{2} + 4M_8 + \frac{M_1 - M_2}{2} \right] \text{mg per 100 ml}$$

APPENDIX B

[*Table* 1, *Sl No.* (xvii)]

PROCEDURE FOR DETERMINING FILTERABILITY OF HYDRAULIC FLUIDS

B-1. SCOPE

B-1.1 This procedure is intended to evaluate filterability characteristic s of petroleum base and synthetic hydraulic fluids.

B-2. INTRODUCTION

B-2.1 Many fluids used in industrial and mobile hydraulic systems do not filter easily, especially in presence of small amounts (less than 2 percent) of water contamination in the system. This may result in plugging of system filters, and thereby drastically increasing the contamination wear of pumps and other components in the system. The test outlined below permits the evaluation of this important quality of the hydraulic fluids.

B-3. TEST PROCEDURE

B-3.1 Prepare two 100 ml samples of test fluid as received.

B-3.2 Prepare two 100 ml samples of test fluid with 2 percent by volume of distilled water added as follows:

a) Add a measured quantity of distilled water to the test hydraulic fluid.

b) Shake the mixture vigorously on a paint shaker for five minutes.

c) Evacuate all visible air from fluid by applying a vacuum.

B-3.3 Test all four samples using an apparatus similar to that shown in Fig. 2. All samples are to be tested at room temperature (18 to 24°C typical). Use a fresh 1·2 micron absolute membrane filter disc, which has a 9·6 square centimetre filtration area, for each sample.

B-3.4 Pour one 100 ml sample in filter funnel. Apply and maintain a vacuum of 65 cm Hg to the filtering apparatus and record the time required to filter 75 ml of sample fluid. Discontinue timing after 600 seconds and record filtration time as 600 +. Repeat for remaining samples.

B-3.5 Inspect and record any residue, other than normal particulate contamination, on the filter disc.

APPENDIX C

[*Table* 1, *Sl No.* (xviii)]

SEAL COMPATIBILITY TEST

C-1. SCOPE

C-1.1 This method determines the compatibility of petroleum oils with nitrile rubber seal material in terms of change in volume percent and shore hardness.

C-2. DEFINITION

C-2.1 Percent Volume Change — It is the difference between the volume of the nitrile rubber specimen before and after the test and its ratio to the volume before the test started, multiplied by 100.

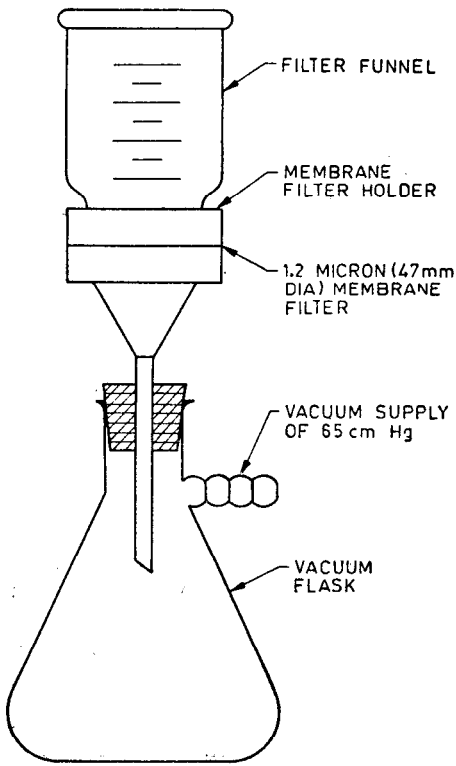


FIG. 2 FILTRATION APPARATUS

C-2.2 Change in Shore Hardness of Nitrile Rubber Specimen — It is the difference in hardness between the initial and after test determined by shore hardness tester.

C-3. SUMMARY OF METHOD

C-3.1 The initial volume and hardness of the nitrile rubber specimen is determined. The specimen is then immersed in the oil for a period of

100 hours at a temperature of 80 ± 2°C. After the test duration, the specimen is cooled to room temperature and change in volume and hardness is determined.

C-4. APPARATUS

C-4.1 Nitrile Rubber Specimen* — This shall be in the form of disc of 36 mm diameter and 6 mm thickness of NBR/101 (nitrile-butadiene rubber).

C-4.2 Analytical Balance — Having sensitivity of 0·1 mg with nylon filament and a beaker containing distilled water on a bridge as shown in Fig. 3.

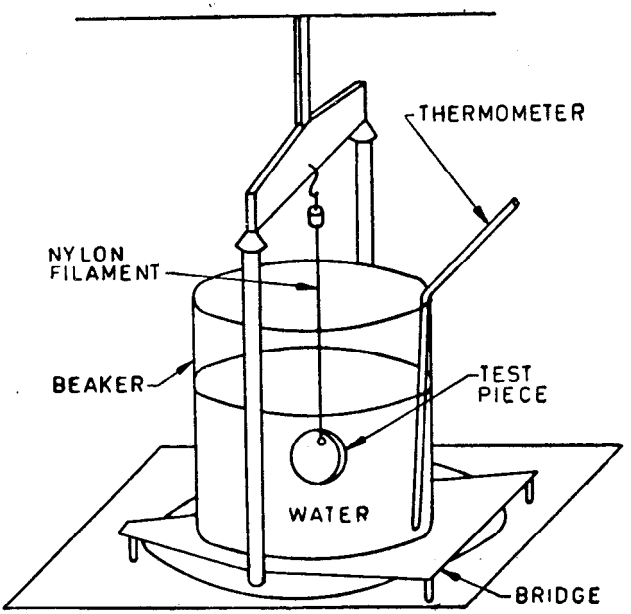


FIG. 3 ANALYTICAL BALANCE FOR WEIGHING IN AIR AND WATER

*Available from Firma Carl Freudenberg GmBH, Post Box 1380, Bergstrasse, 6940 Weinheim, West Germany, Indian Oil Corporaton (R&D), Faridabad may be contacted for the supply of these seals.

C-4.3 Shore Hardness Tester

C-4.4 Glass Jar — Having a ground-glass stopper. The dimensions of the glass jar should be such that the rubber test specimens remain completely immersed in the fluid under test, and free to swell without restraint or distortion. The diameter of the mouth should be such as to allow free entry and exit of specimens.

C-4.5 Oven — A fan-assisted air circulating oven capable of maintaining temperature within ±2 C.

C-5. PROCEDURE

C-5.1 Use three rubber test specimens, weigh each piece in air to the nearest milligram (M_1) and then reweigh each test piece in distilled water (M_2) at the standard laboratory temperature, care being taken to ensure that all air bubbles are removed. Formation of air bubbles may be avoided by dipping the test piece momentarily into a suitable liquid such as methyl alcohol.

C-5.2 Bolt the test pieces dry with filter paper or piece of textile that does not deposit lint.

C-5.3 Measure the hardness of the three test pieces at different points of each test specimen. Mean value of the specimen should be taken.

C-5.4 Immerse the rubber test specimens vertically and keep them separate in the glass jar containing petroleum oil. The amount of oil should be at least 15 times the combined volume of the test pieces and sufficient to keep them totally immersed. Replace the stopper and put the jar and contents in test oven for 100 hours at 80 ± 2°C.

C-5.5 At the end of 100 hours bring the jar and contents to the standard laboratory temperature.

C-5.6 Remove any surplus oil from the surface of the test piece. For complete removal of oil, dip each test piece momentarily in a suitable volatile liquid such as petroleum ether and again quickly wipe with filter paper or a piece of textile which does not deposit lint.

C-5.7 Place the test piece immediately in a tared and stoppered weighing bottle and determine its mass in air (M_3) to the nearest milligram at the standard laboratory temperature.

C-5.8 Remove the test piece from the bottle and immediately weigh in distilled water (M_4) at the standard laboratory temperature.

C-5.9 Measure the hardness of specimens after C-5.8 as described in C-5.2.

C-6. METHOD OF CALCULATION

C-6.1 Volume change, percent $= \frac{(M_3 - M_4) - (M_1 - M_2) \times 100}{(M_1 - M_2)}$

where

M_1 = initial mass in g of the rubber specimen in air,

M_2 = initial apparent mass in g of rubber specimen in water,

M_3 = mass in g in air of the rubber specimen after immersion, and

M_4 = apparent mass in g in water of the rubber specimen after immersion.

C-6.1.1 The arithmetic mean of three measurements should be taken.

C-6.2 Change in shore hardness — Initial mean hardness of the rubber specimen — Mean hardness of the rubber specimen after immersion

C-7. PRECISION OF THE TEST METHOD

C-7.1 Precision of the test method is yet to be established.

(*Continued from page* 2)

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SHRI A. K. MISRA	Bokaro Steel Plant (SAIL), Bokaro
SHRI M. P. PATHAK (*Alternate*)	
SHRI K. K. RAI	Indian Oil Corporation Ltd (Marketing Division), Bombay
SHRI FAKIRA SINGH (*Alternate*)	
SHRI V. RAMACHANDRAN	Brakes India Ltd, Madras
SHRI R. KRISHNAMOORTY (*Alternate*)	
SHRI R. H. RATHOD	Swastik Oil Products Manufacturing Co, Bombay
SHRI B. SANGHAVI	Lubrizol India Ltd, Bombay
SHRI R. A. RAO (*Alternate*)	
SHRI V. R. SESHU	Hindustan Petroleum Corporation Ltd, Bombay
SHRI P. KRISHNAMOORTHY (*Alternate*)	
DR A. SETHURAMIAH	Indian Institute of Petroleum, Dehra Dun
SHRI S. K. JAIN (*Alternate*)	
SHRI M. J. SHAH	Indian Oil Blending Ltd, Bombay
SHRI M. K. DUTTA (*Alternate*)	
SHRI J. P. SHARMA	Ministry of Defence (DG I)
SHRI H. C. GUPTA (*Alternate*)	

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Members	*Representing*
SHRI A. SHANTHARAM	HMT Ltd, Bangalore
SHRI K. B. SHRIVASTAVA	Tide Water Oil Co (India) Ltd, Calcutta
SHRI J. NAIK (*Alternate* I)	
SHRI N. C. MITTAL (*Alternate* II)	
SHRI D. K. SINGH	Bharat Heavy Electricals Ltd, Bhopal
SHRI L. PUNDAREEK (*Alternate* I)	
SHRI B. S. SRIVASTAVA (*Alternate* II)	
DR R. D. SRIVASTAVA	Ministry of Defence (R & D)
SHRI RAJENDRA SINGH (*Alternate*)	
SHRI T. V. VARGHESE	Madras Refineries Ltd, Madras
SHRI V. K. GOPINATH (*Alternate*)	